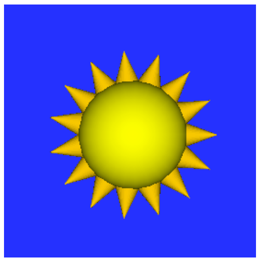
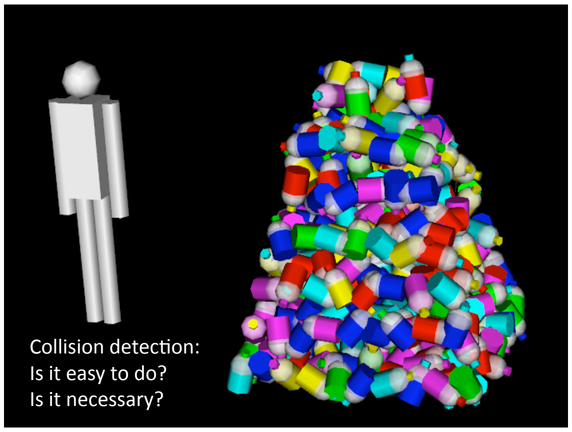
VTK Graphs Cmake & Git

Today's Class

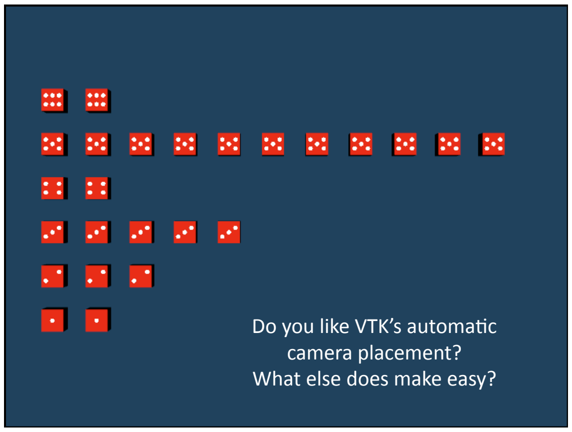
- Highlights from HW #1
- This Week's Readings
- Next Week's Readings

- VTK Graphs
- Intro to Cmake
- Intro to Git



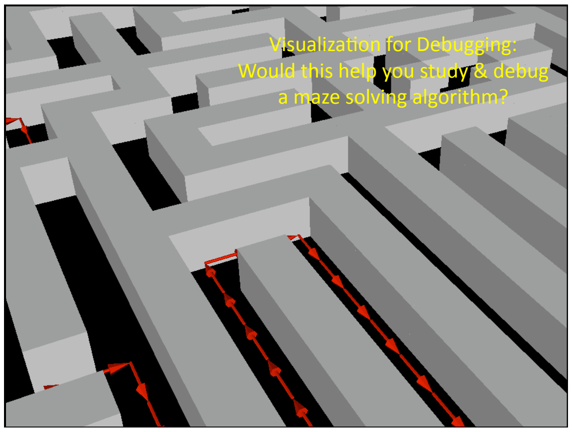


Collision detection:
Is it easy to do?
Is it necessary?

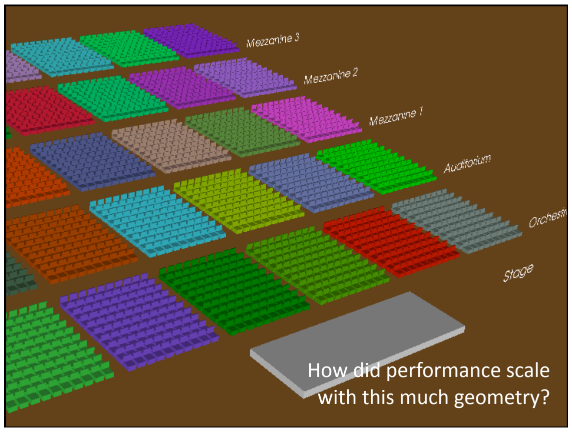


Do you like VTK's automatic camera placement?
What else does make easy?

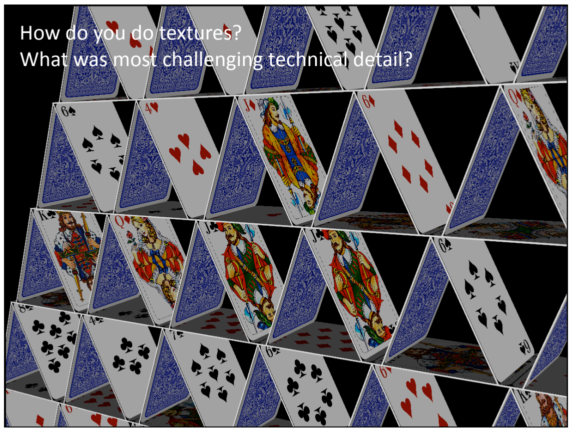
Hierarchy of Transformation?
Any VTK Tips/Tricks?



Visualization for Debugging:
Would this help you study & debug a maze solving algorithm?



How did performance scale with this much geometry?



How do you do textures?
What was most challenging technical detail?

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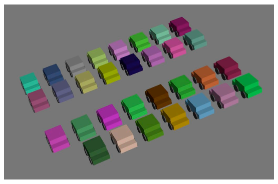

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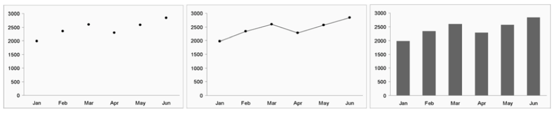
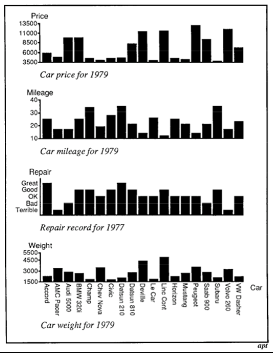
Readings for This Week:

- "Eenie, Meenie, Minie, Moe: Selecting the Right Graph for Your Message" Stephen Few, 2004



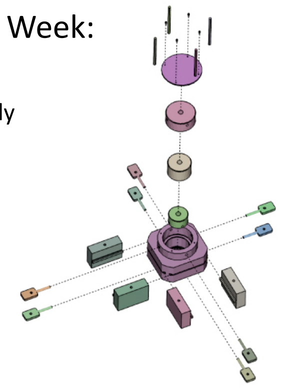
Readings for This Week:

- "Automating the design of graphical presentations of relational information" Jock Mackinlay, 1986



Readings for This Week:

- "Designing Effective Step-By-Step Assembly Instructions" Agrawala et al., 2003



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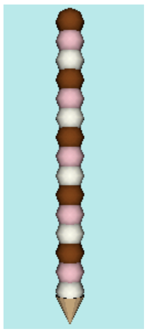
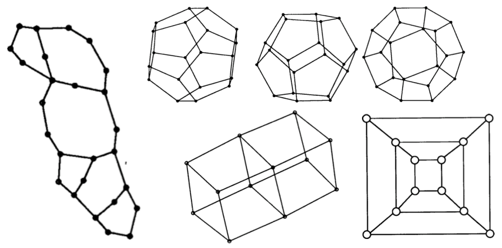


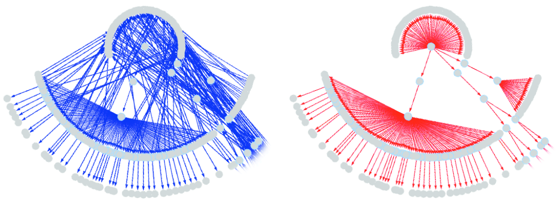
Readings for Next Week:

- "Graph drawing by force-directed placement", Fruchterman & Reingold, 1991



Readings for Next Week:

- "Heapviz: Interactive Heap Visualization for Program Understanding and Debugging" Aftandilian, Kelley, Gramazio, Ricci, Su, & Guyer, 2010



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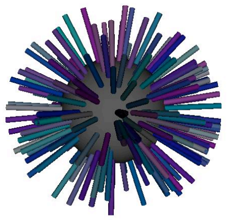


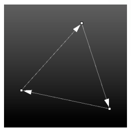
Introduction to VTK: Graphs

Graph Theory 101

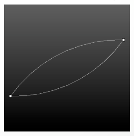
- A graph consists of:
  - Edges – the "points"
  - Vertices – the "lines"

Types of Graphs

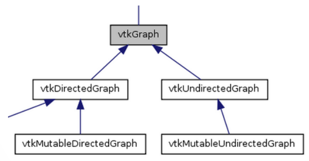
- Directed
  - One vertex "points" to another



- Undirected
  - Two vertices are connected (they both point to each other)



Graphs in VTK



http://www.vtk.org/Wiki/VTK/Examples/Cxx#Graphs

Constructing Graphs

- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Graphs/VisualizeGraph
- Use these to construct graphs
  - vtkMutableUndirectedGraph
  - vtkMutableDirectedGraph

```
vtkSmartPointer<vtkMutableUndirectedGraph> g =
  vtkSmartPointer<vtkMutableUndirectedGraph>::New();
vtkIdType v1 = g->AddVertex();
vtkIdType v2 = g->AddVertex();
g->AddEdge ( v1, v2 );
```

Graph Data

- VertexData
  - You can store data for every vertex
  - Colors, ids, names, etc
  - graph->GetVertexData()->AddArray(yourFavoriteArray);
- EdgeData
  - You can store data for every edge
  - Edge weights, colors, etc
  - graph->GetEdgeData()->AddArray(yourFavoriteArray);
  - http://www.vtk.org/Wiki/VTK/Examples/Cxx/Graphs/EdgeWeights

Graph Data: Example

```
… Create a graph with 3 vertices and 3 edges …

// Create the edge weight array
vtkSmartPointer<vtkDoubleArray> weights =
  vtkSmartPointer<vtkDoubleArray>::New();
weights->SetNumberOfComponents(1);
weights->SetName("Weights");

// Set the edge weights
weights->InsertNextValue(1.0);
weights->InsertNextValue(1.0);
weights->InsertNextValue(2.0);

// Create the vertex id array
vtkSmartPointer<vtkIntArray> vertexIDs =
  vtkSmartPointer<vtkIntArray>::New();
vertexIDs->SetNumberOfComponents(1);
vertexIDs->SetName("VertexIDs");

// Set the vertex ids
vertexIDs->InsertNextValue(0);
vertexIDs->InsertNextValue(1);
vertexIDs->InsertNextValue(2);

// Add the edge weight array to the graph
g->GetEdgeData()->AddArray(weights);
g->GetVertexData()->AddArray(vertexIDs);
```

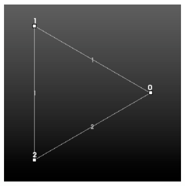
Displaying Graphs

- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Graphs/VisualizeGraph

```
vtkSmartPointer<vtkGraphLayoutView> graphLayoutView =
  vtkSmartPointer<vtkGraphLayoutView>::New();
graphLayoutView->AddRepresentationFromInput(g);
graphLayoutView->ResetCamera();
graphLayoutView->Render();
graphLayoutView->GetInteractor()->Start();
```

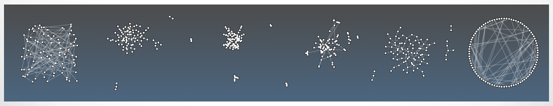
Displaying Vertex and Edge Labels

```
graphLayoutView->SetVertexLabelVisibility(true);
graphLayoutView->SetEdgeLabelVisibility(true); graphLayoutView-
>SetEdgeLabelArrayName("Weights"); graphLayoutView-
>SetVertexLabelArrayName("VertexIDs");
```



Layout Strategies

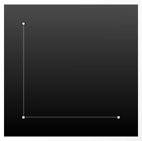
- graphLayoutView->SetLayoutStrategy("Strategy Name");
  - "Random" - Randomly places vertices in a box
  - "Force Directed" - Simulating forces (springs) on edges
  - "Simple 2D" - A simple 2D force directed layout
  - "Clustering 2D" - Just like simple 2D but uses some techniques to cluster better
  - "Fast 2D" - A linear-time 2D layout.
  - "Circular"



Vertex Coodinates

- You can also specify the "Pass Through" layout strategy
- This allows you to set the coordinates of the vertices manually:

```
vtkSmartPointer<vtkPoints> points =
  vtkSmartPointer<vtkPoints>::New();
points->InsertNextPoint(0.0, 0.0, 0.0);
points->InsertNextPoint(1.0, 0.0, 0.0);
points->InsertNextPoint(0.0, 1.0, 0.0);
g->SetPoints(points);
```



Neighboring Vertices

- vtkAdjacentVertexIterator

```
vtkSmartPointer<vtkAdjacentVertexIterator> iterator =
  vtkSmartPointer<vtkAdjacentVertexIterator>::New();
g->GetAdjacentVertices(0, iterator);

while(iterator->HasNext())
 {
 vtkIdType nextVertex = iterator->Next();
 std::cout << "Next vertex: " << nextVertex << std::endl;
 }
```

Lookup Tables

- Automatic map from a range to all colors:

```
vtkLookupTable* lookupTable =
  vtkLookupTable::New();
lookupTable->SetTableRange(0.0, 10.0);
lookupTable->Build();
```

- Manually specify colors in the table:

```
vtkSmartPointer<vtkLookupTable> lookupTable =
  vtkSmartPointer<vtkLookupTable>::New();
lookupTable->SetNumberOfTableValues(2);
lookupTable->SetTableValue(0, 1.0, 0.0, 0.0); // red
lookupTable->SetTableValue(1, 0.0, 1.0, 0.0); // green
lookupTable->Build();
```

Color Vertices

- http://www.vtk.org/Wiki/VTK/Examples/Cxx/Graphs/ColorVertices

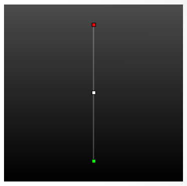
```
// Create the color array
vtkIntArray* vertexColors =
  vtkIntArray::New();
vertexColors->SetName("VertexColors");
vertexColors->SetNumberOfComponents(1);
vertexColors->InsertNextValue(1);
vertexColors->InsertNextValue(2);
…

… Create a lookup table …

// Add the color array to the graph
graph->GetVertexData()->AddArray(vertexColors);

vtkViewTheme* theme =
  vtkViewTheme::New();
theme->SetPointLookupTable(lookupTable);
graphLayoutView->ApplyViewTheme(theme);

graphLayoutView->SetVertexColorArrayName("VertexColors");
graphLayoutView->ColorVerticesOn();
```



Color Edges

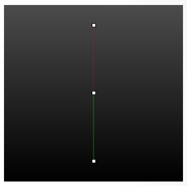
```
// Create the color array
vtkIntArray* edgeColors =
  vtkIntArray::New();
edgeColors->SetName("EdgeColors");
edgeColors->SetNumberOfComponents(1);
edgeColors->InsertNextValue(1);
edgeColors->InsertNextValue(2);
…

… Create a lookup table …

// Add the color array to the graph
graph->GetEdgeData()->AddArray(edgeColors);

vtkViewTheme* theme =
  vtkViewTheme::New();
theme->SetCellLookupTable(lookupTable);
graphLayoutView->ApplyViewTheme(theme);

graphLayoutView->SetVertexColorArrayName("EdgeColors");
graphLayoutView->ColorEdgesOn();
```



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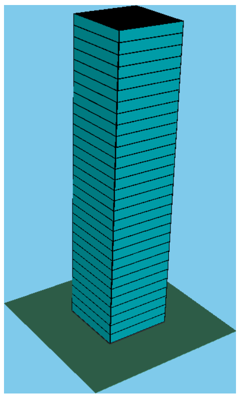


Introduction to VTK: CMake

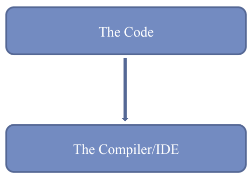
What is CMake?

- Cross platform Make
- Allows the same source code to be compiled on many different operating systems and IDEs (Integrated Development Environment)
  - Visual Studio
  - Code Blocks
  - KDevelop
  - Eclipse
  - Traditional Unix Makefile
  - Etc.

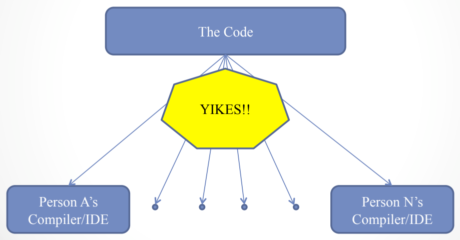
The Idea

- Software used to ship with a Makefile
- The settings for library paths, which options you wanted to use for the compilation and installation were hard coded into the Makefile
- Autoconf and similar packages attempted to make this a little easier
- CMake makes it VERY easy

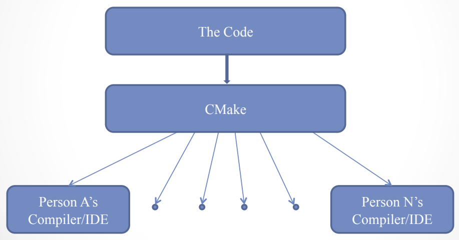
Single Person Project



Collaborative ("Real") Project



Collaborative ("Real") Project



The Magic File – CMakeLists.txt

```
PROJECT(YourExampleProject)

FIND_PACKAGE(VTK REQUIRED)
INCLUDE(${VTK_USE_FILE})

ADD_EXECUTABLE(ExampleExecutable ExampleCode.cxx)
TARGET_LINK_LIBRARIES(ExampleExecutable vtkHybrid)
```

Line-by-line

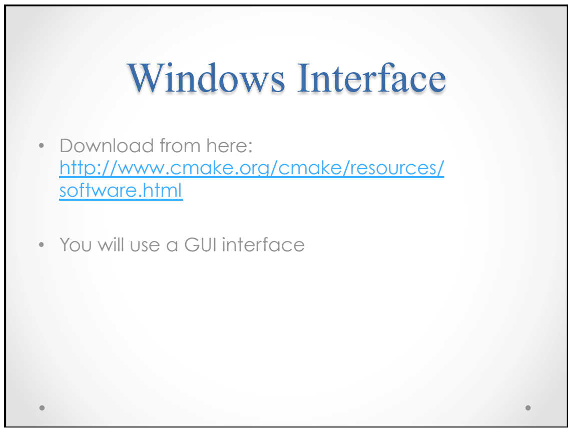
- PROJECT(YourExampleProject)
- Tell CMake you are starting a new project

Line-by-line

- FIND_PACKAGE(VTK REQUIRED)
- INCLUDE(${VTK_USE_FILE})
- Tell CMake you want to use VTK in your new project
- If you have the environment variable VTK_BIN set, CMake will find VTK automatically
- If not, when you configure your project using CMake it will ask you where you have VTK installed

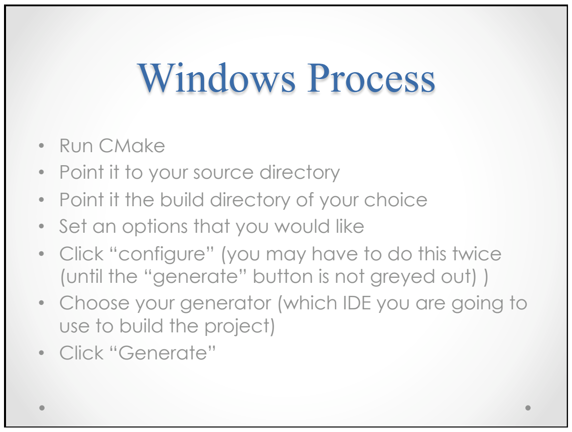
Line-by-line

- ADD_EXECUTABLE(ExampleExecutable ExampleCode.cxx)
- Tell CMake you want to create an executable called ExampleExecutable from ExampleCode.cxx
- TARGET_LINK_LIBRARIES(ExampleExecutable vtkHybrid)
- Tell CMake that ExampleCode.cxx uses functions defined in the library vtkHybrid. You can list as many libraries as you need.
- TARGET_LINK_LIBRARIES(ExampleExecutable vtkHybrid vtkInfovis OtherLibrary)



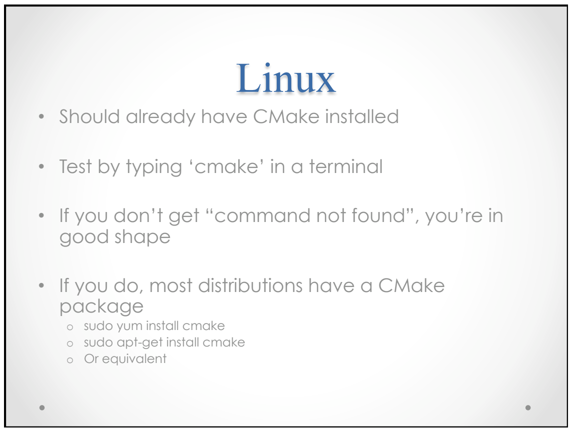
Windows Interface

- Download from here: http://www.cmake.org/cmake/resources/software.html
- You will use a GUI interface



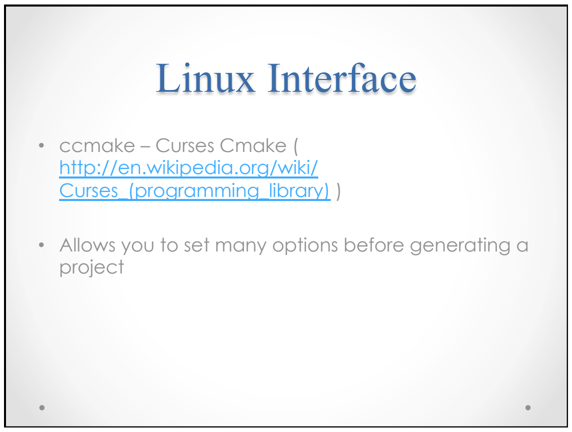
Windows Process

- Run CMake
- Point it to your source directory
- Point it the build directory of your choice
- Set an options that you would like
- Click "configure" (you may have to do this twice (until the "generate" button is not greyed out))
- Choose your generator (which IDE you are going to use to build the project)
- Click "Generate"



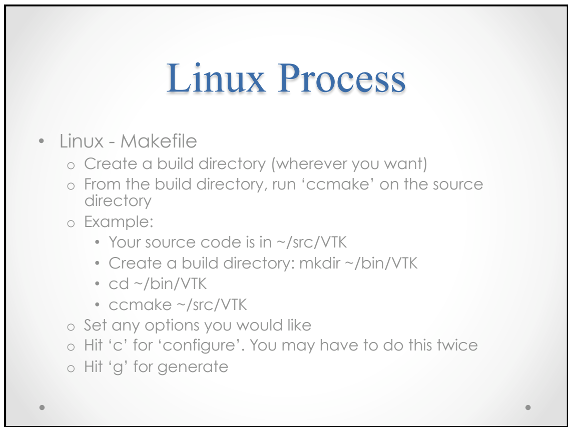
Linux

- Should already have CMake installed
- Test by typing 'cmake' in a terminal
- If you don't get "command not found", you're in good shape
- If you do, most distributions have a CMake package
  - sudo yum install cmake
  - sudo apt-get install cmake
  - Or equivalent



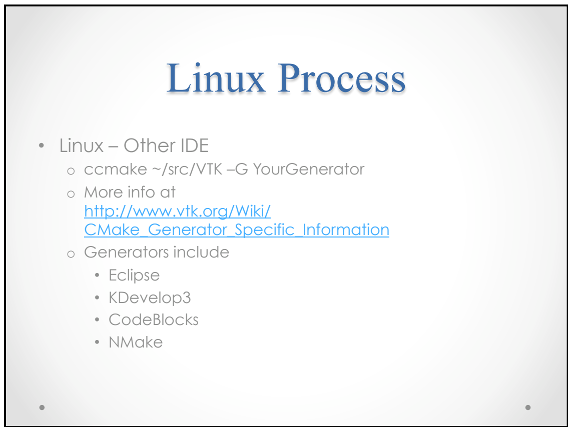
Linux Interface

- ccmake – Curses Cmake (http://en.wikipedia.org/wiki/Curses_(programming_library))
- Allows you to set many options before generating a project



Linux Process

- Linux - Makefile
  - Create a build directory (wherever you want)
  - From the build directory, run 'ccmake' on the source directory
  - Example:
    - Your source code is in ~/src/VTK
    - Create a build directory: mkdir ~/bin/VTK
    - cd ~/bin/VTK
    - ccmake ~/src/VTK
  - Set any options you would like
  - Hit 'c' for 'configure'. You may have to do this twice
  - Hit 'g' for generate



Linux Process

- Linux – Other IDE
  - ccmake ~/src/VTK –G YourGenerator
  - More info at http://www.vtk.org/Wiki/CMake_Generator_Specific_Information
  - Generators include
    - Eclipse
    - KDevelop3
    - CodeBlocks
    - NMake

First Time VTK Programming

- Step 1 – Download the VTK source code
- Step 2 – Use CMake to create a project for the IDE you want to use to compile VTK
- Step 3 – Use the IDE you selected in Step 2 to build VTK
- Step 4 – Obtain an example program and associated CMakeLists.txt file from the Examples Wiki
- Step 5 – Use CMake to create a project for the IDE you want to use to compile the example program
- Step 6 – Use the IDE you selected in Step 5 to build the example program

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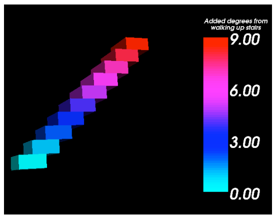


Introduction to VTK: Git

What is Git?

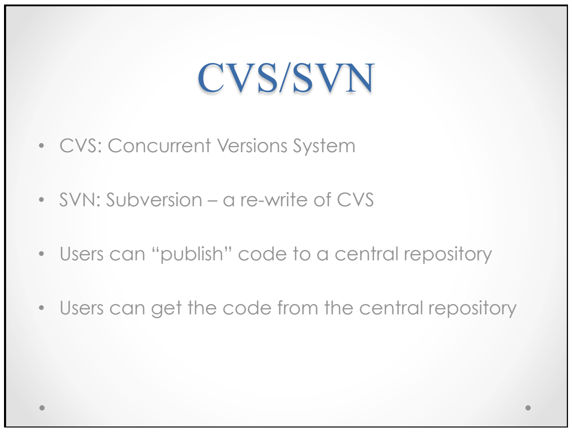
- The latest and greatest version control system
- Makes large projects easier to manage
- Written by Linus Torvalds (the Linux guy) to help with the massive Linux project

Version Control Systems – A Brief History

- Patches
- CVS/SVN
- Git

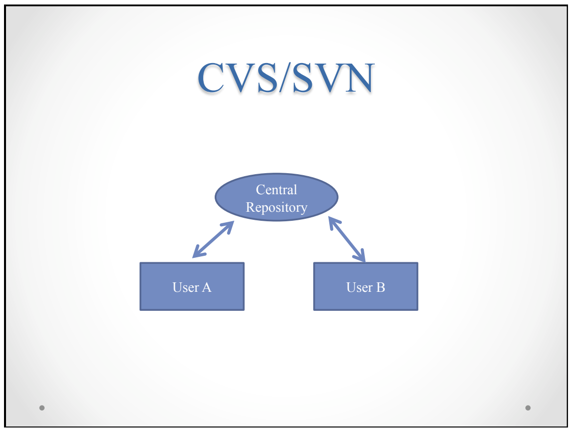
The Olden Days

- In the "olden days", people would send patches back and forth to each other via email
- This was terribly inefficient
- The patch would only work with the exact file that it was created for
- No version control

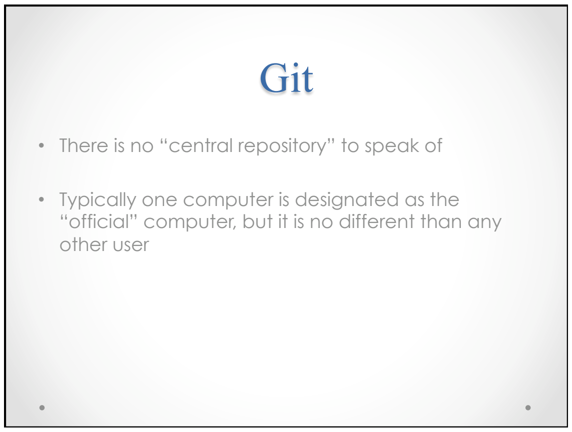


CVS/SVN

- CVS: Concurrent Versions System
- SVN: Subversion – a re-write of CVS
- Users can “publish” code to a central repository
- Users can get the code from the central repository

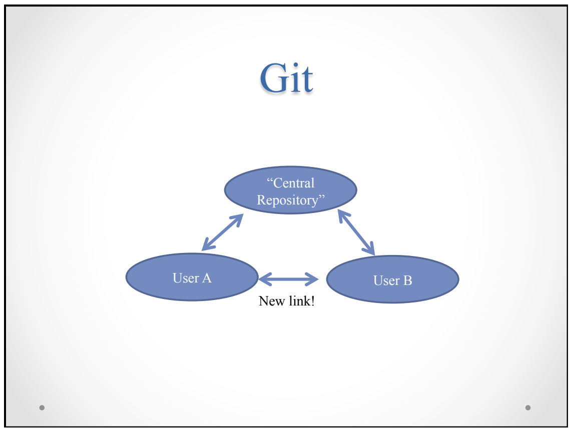


CVS/SVN

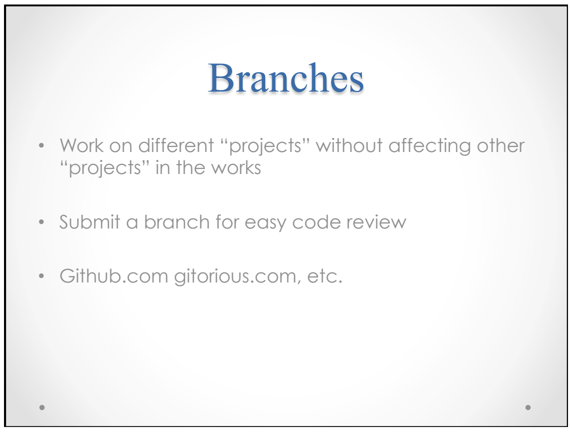


Git

- There is no “central repository” to speak of
- Typically one computer is designated as the “official” computer, but it is no different than any other user



Git



Branches

- Work on different “projects” without affecting other “projects” in the works
- Submit a branch for easy code review
- Github.com gitorious.com, etc.